SOIL, LAND CAPABILITY AND AGRICULTURAL POTENTIAL STUDY ON PORTION 1 OF THE FARM GROOTPOORT 168 RD, FREE STATE PROVINCE

NOVEMBER 2015

CONDUCTED BY:

ENVIRONMENT RESEARCH CONSULTING

A.R. Götze (M.Sc.) Pr.Sci.Nat.

E-mail: erc@telkomsa.net Mobile: 082 789 4669

Fax: 086 621 4843

EXECUTIVE SUMMARY

Based on the findings of the soil and land capability study it is the opinion of the investigating scientist that from a soil conservation and agricultural potential point of view, the proposed development is considered favourably, provided that due care is taken to minimise impacts on soils and land capability through the minimization of footprint areas and through good soil management principles.

Introduction

Environment Research Consulting (ERC) was appointed by Environamics cc on behalf of Pele Green Energy (Pty) Ltd to conduct a soil, land capability and agricultural potential study for a proposed 84 MW photovoltaic solar energy facility approximately 14 km south west of Luckhoff in the Letsemeng Local Municipality in the Free State Province. An assessment of the soils of the project area was conducted on 02 and 03 November 2015 by A.R. Götze of ERC, a registered Professional Natural Scientist. The main purpose of the study was to determine the soil forms and current land capability and agricultural potential of the area where the proposed project will be situated. Soil samples for chemical and soil-physical analysis were also taken during the site visit.

Land type information

Only one land type is described for the study area. The Ag151 Land Type includes areas with red to yellow apedal, freely drained soils, with high base status and generally less than 300 mm deep. Less than 10% of the Ag 151 land type is marginally suitable for crop production and mostly with severe soil and climate limitations.

Soil classification

Two soil form groups with six soil forms were identified in the study area (Table A). The site is characterized by mostly shallow to some moderately deep calcic, oxic and lithic soils with an average **effective soil depth** of only 53 cm. The shallowest soil profiles are less than 10 cm in depth and the deepest profile was measured at 130 cm.

For the largest part, the **soil colour** is fairly homogenous throughout the study area and most areas have a soil colour of 2.5 YR 5/4 according to the Munsell colour chart.

Table A: Summary of soil form groups and soil forms and the area (ha) that each group covers in the study area

SOIL FORM GROUP	SOIL FORMS	AREA (ha)	% OF STUDY AREA	MAP COLOUR (Figure 6)
1. Moderately deep oxic to shallow lithic soils	Hutton (72%)	119.95	52	
	Mispah (28%)			
2. Moderately deep to shallow calcic soils	Kimberley (57%)	110.96	48	
	Plooysburg (23%)			
	Brandvlei (19%)			
	Coega (1%)			
	Total:	**230.91**	**100**	

Chemical and physical soil properties

A chemical analysis of five representative composite soil samples that were collected in the study area is included as baseline data. The results of the analyses are included in Table 4 (p.24). All soil samples were taken as representative composite samples of the top 30 cm of all the recorded soil forms in the study area. The pH of the analysed soil samples, collected in the study area, range between 5.4 (strongly acidic) and 7.3 (neutral). Potassium levels range between 91 and 197 mg/kg and according to the lab results the phosphorus (P) levels for all analysed samples is 0.0 mg/kg, which reflects a serious P deficiency. The cation chemistry (Ca, Mg, K, Na – content and relationships) is typical to that of the soil forms in the area of the proposed project. No serious extremes in terms of the soil chemistry were recorded.

The soil texture of all collected samples were analysed and all have a clay content of ≤10 % (loamy-sand).

Agricultural potential & Land use

It is concluded that the study site has no potential for dry land crop farming, but may have a marginal potential for small scale crop production under irrigation. A major irrigation canal from the Van der Kloof Dam passes about 1 km south-east of the south-eastern corner of the study area, which may be able to supply water for irrigation. This water will however have to be pumped to the site as it is situated slightly higher up the landscape from the canal.

The site is currently utilized for sheep and game farming and doe indeed have some potential for sheep, goat and/or game farming although the current overall veld condition is estimated to be below 30 %.

It is furthermore concluded that should the development be authorised, it will have a moderately low impact on agricultural potential in terms of crop production as well as the production of livestock and game. The surrounding land in the area is also used for extensive livestock farming activities.

No noticeable tourism activities are present within a 500m radius surrounding the site. It is anticipated that the proposed change in land use of the study site will not dramatically result in any negative impact on the surrounding land users for it will not result in any physical or chemical pollution that will affect neighbouring properties.

Environmental impacts

Four possible impacts on the soil and current land use of the area are described. Table B below summarises the findings indicating the significance of the impact before mitigation takes place and the likely impact if management when mitigation takes place. In the consideration of mitigation it is assumed that a high level of mitigation takes place but does not lead to prohibitive costs. From Table B it is evident that prior to mitigation all of the impacts range between high and low level impacts but with proper mitigation measures all impacts can be reduced to low level.

Table B: A summary of the results impacts assessed

Impact	Impact level pre-mitigation	Impact level post mitigation
Soil erosion	High	Low
Soil compaction	Medium-high	Low
Chemical soil pollution	High	Low
Change in grazing land use	Low	Low

Table of Contents

List of Tables

List of Figures

1. INTRODUCTION

Environment Research Consulting (ERC) was appointed by Environamics cc on behalf of Pele Green Energy (Pty) Ltd to conduct a soil, land capability and agricultural potential study for a proposed 84 MW photovoltaic solar energy facility approximately 14 km south west of Luckhoff in the Letsemeng Local Municipality in the Free State Province. An assessment of the soils of the project area was conducted on 02 and 03 November 2015 by A.R. Götze of ERC, a registered Professional Natural Scientist. The main purpose of the study was to determine the soil forms and current land capability and agricultural potential of the area where the proposed project will be situated. Soil samples for chemical and soil-physical analysis were also taken during the site visit.

The objectives of this assessment were:

- to describe the soils (distribution, types, depth, surface features, suitability for agriculture, physical and chemical characteristics, fertility, erodability, dry land production potential and irrigation potential),
- to determine the pre-development land capability,
- to determine the present land use,
- to conduct an Impact Assessment for the soils and land capability which will feed into the overall Environmental Impact Assessment, and
- to propose mitigation measures for the impacts to form part of the Environmental Management Program.

Since agricultural potential of land is largely determined by the soil characteristics together with climatic conditions, a soil survey was conducted to establish homogenous soil units and their distribution. These units could, in turn, be assessed in terms of their agricultural potential for different farming operations like animal production and irrigated crop production, taking the rainfall, temperature and soil potential into consideration.

2. IDENTIFICATION OF ASSUMPTIONS AND LIMITATIONS

The following knowledge gaps existed during compilation of this report and may have an effect on the conclusions made:

- The exact layout of the proposed project was not made available.
- The detailed method of construction and operation of the proposed solar plant was not provided.

The following assumptions were made with regards to assessing the potential soil impacts:

- The project cycle will consist of construction, operational and decommissioning phases.
- The photo-voltaic panels will be constructed with concrete piers.
- Batteries and other equipment will not be disposed on site.
- The area will not expand beyond the current proposed footprint.

3. LOCALITY OF THE STUDY AREA

The study area is situated on Portion 1 of the farm Grootpoort 168 RD approximately 14 km south-west of Luckhoff in the Letsemeng Local Municipality in the Free State Province. The area that was specifically studied covers an area of approximately 230 ha of the farm Grootpoort.

The site is generally accessed from the north-east via Luckhoff on the R48 road and the Northern Cape towns of Van Der Kloof and Orania are about 17 km south-east and 22 km west of the study area respectively (Figure 1).

It is envisaged that the proposed 84 MW photovoltaic solar energy facility and associated of which the generated power will be fed into the Eskom electricity grid. The total footprint of the project will be approximately 140 hectares.

Figure 1: Google earth image indicating the regional locality of the study area.

4. CLIMATE OF THE STUDY AREA

The area receives an average of 378 mm of precipitation per calendar year. Most rainfall occurs in summer with the highest rainfall in February (average: 72 mm) and the lowest experienced during July (average: 9 mm) (Figure 2). The climate can be considered to be semi-arid with hot summers and cold winter temperatures and the monthly distribution of average daily maximum temperatures ranging from 15 ºC in June to 28 ºC in January (Figure 3). The region is coldest during July when temperatures often drop to below 0 ºC during the nights. Frost occurs between the end of May and the beginning of September.

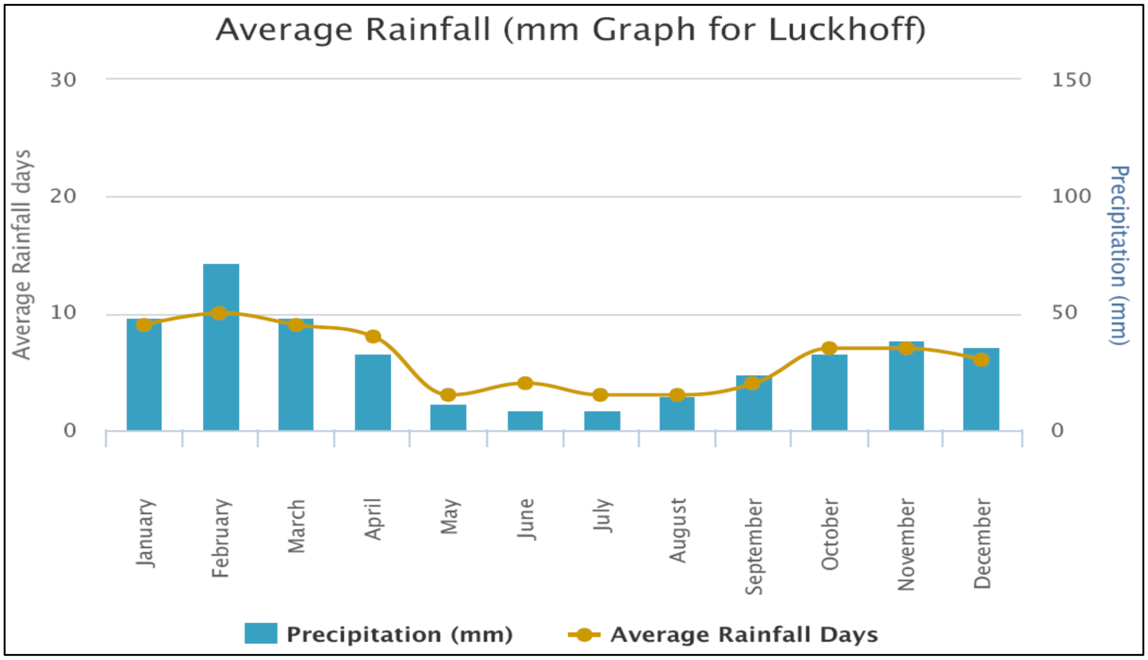

Figure 2: Graph indicating the average rainfall figures for Luckhoff for the period 2000 to 2012 (World Weather Online).

Due mainly to the low annual rainfall the study area will not be suitable for dry land crop production. It is generally accepted that for an area to be suitable for dry land crop production the MAP should be more than 550 mm.

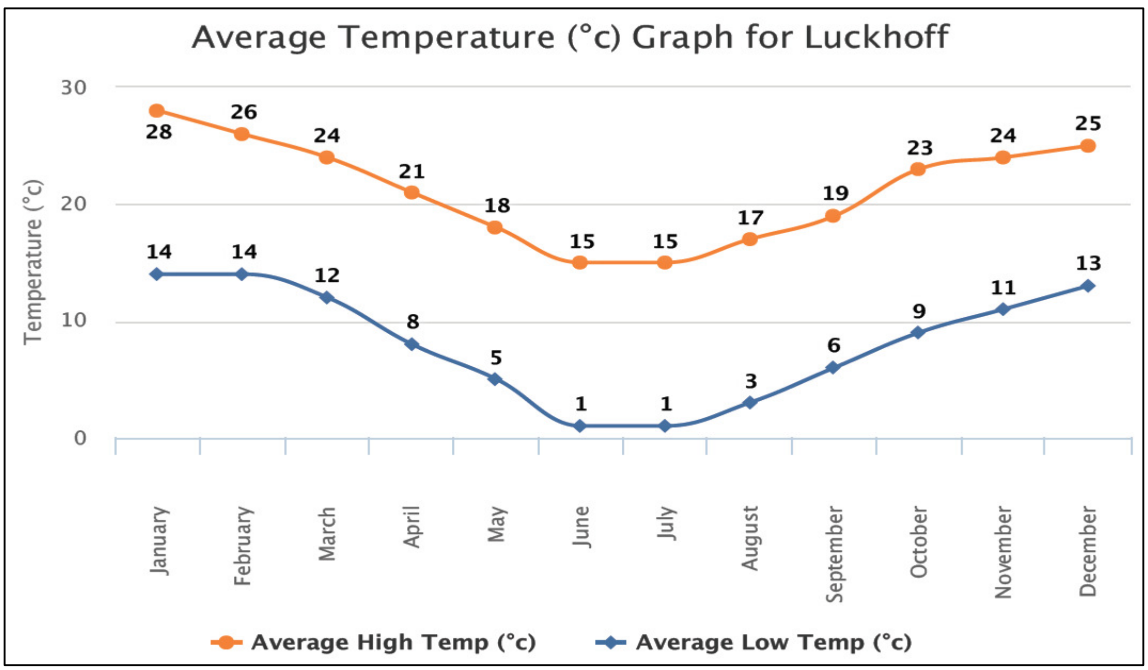

Figure 3: Graph indicating the average minimum and maximum temperatures for Luckhoff for the period 2000 to 2012 (World Weather Online).

5. GEOLOGY AND TOPOGRAPHYOF THE STUDY AREA

The study area is underlain by shale of the Ecca Group (Karoo Sequence) with some dolerite intrusions (Figure 4).

The topography of the ± 230 ha studied area includes small upland plains gently to steeply sloping toward the north and north-east and also including a low ridge in the southern parts with eroded drainage lines down the natural slope especially the north-eastern parts. Slopes for the largest part of the study area range between 5 º to 15 º; some short, steep inclines (± 20 – 30º), however, occur along the northern and north-eastern edge of the mentioned low ridge.

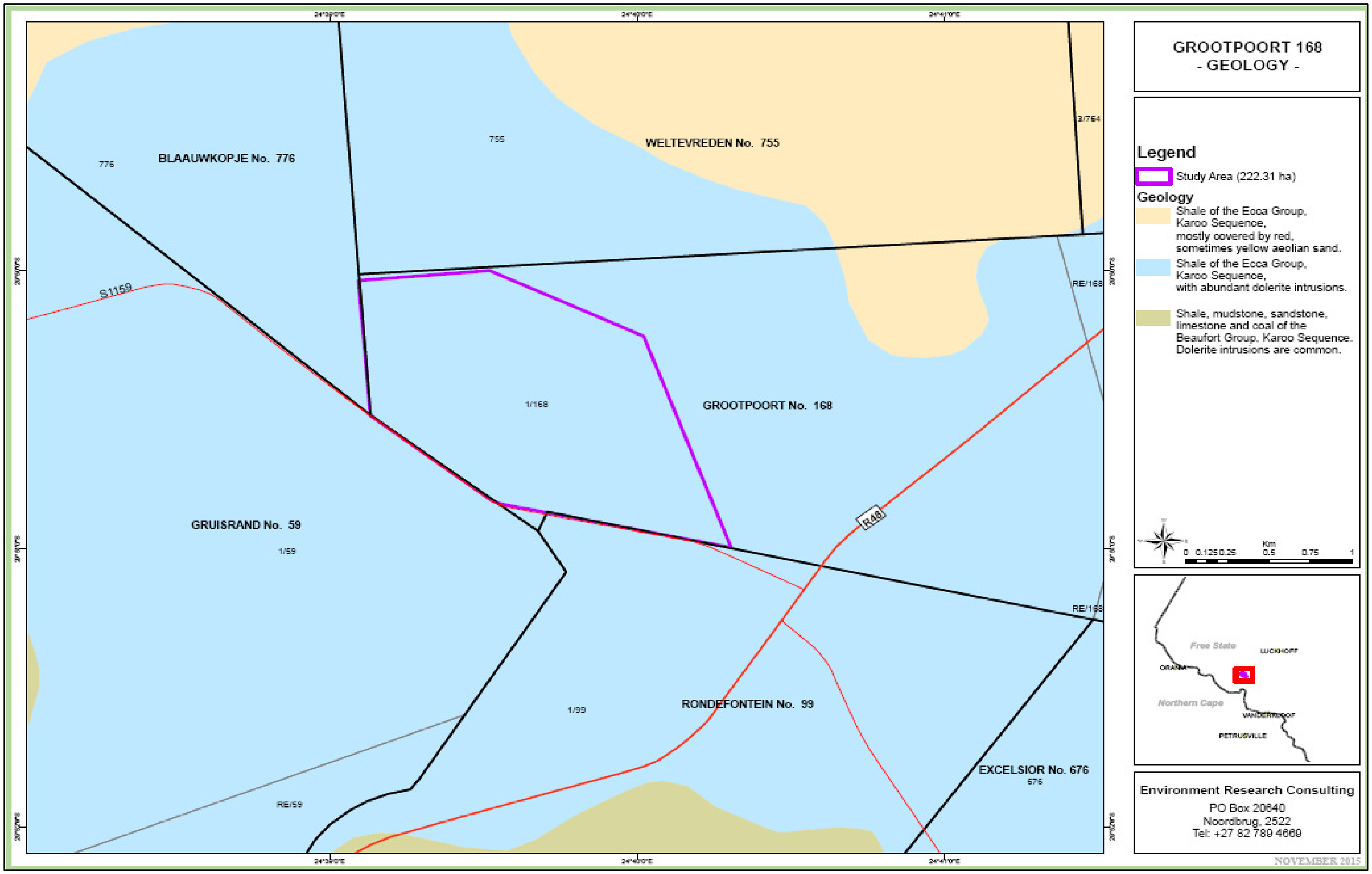

Figure 4: Geological formations relevant to the study area and surroundings (ENPAT Data, Dept. of Environmental Affairs).

6. LAND TYPE DATA ASSESSMENT

6.1 Background information

The following abstract from Sililo *et al.* (2000) gives an introduction into the development and usefulness of a land type data system:

"In South Africa, land type maps were designed to assist in assessing agricultural potential. The procedure followed in mapping land types was described by the Institute of Soil, Climate and Water (Land type Survey Staff, 1987)."

Land type data was developed by superimposing broad soil groups developed from the Binomial Soil Classification System (MacVicar, 1977) with maps of climate zone. This resulted in the land type maps that indicated land type boundaries with an inventory for each land type that include clay percentage as well as other information regarding the area that can be used to interpret soil classification results more successfully.

6.2 Land type results

According to the available Land Type data only one land type occurs in the studied area (Figure 5). The Ag151 Land Type includes areas with red to yellow apedal, freely drained soils, with high base status and generally less than 300 mm deep. Less than 10% of the Ag 151 land type is marginally suitable for crop production and mostly with severe soil and climate limitations.

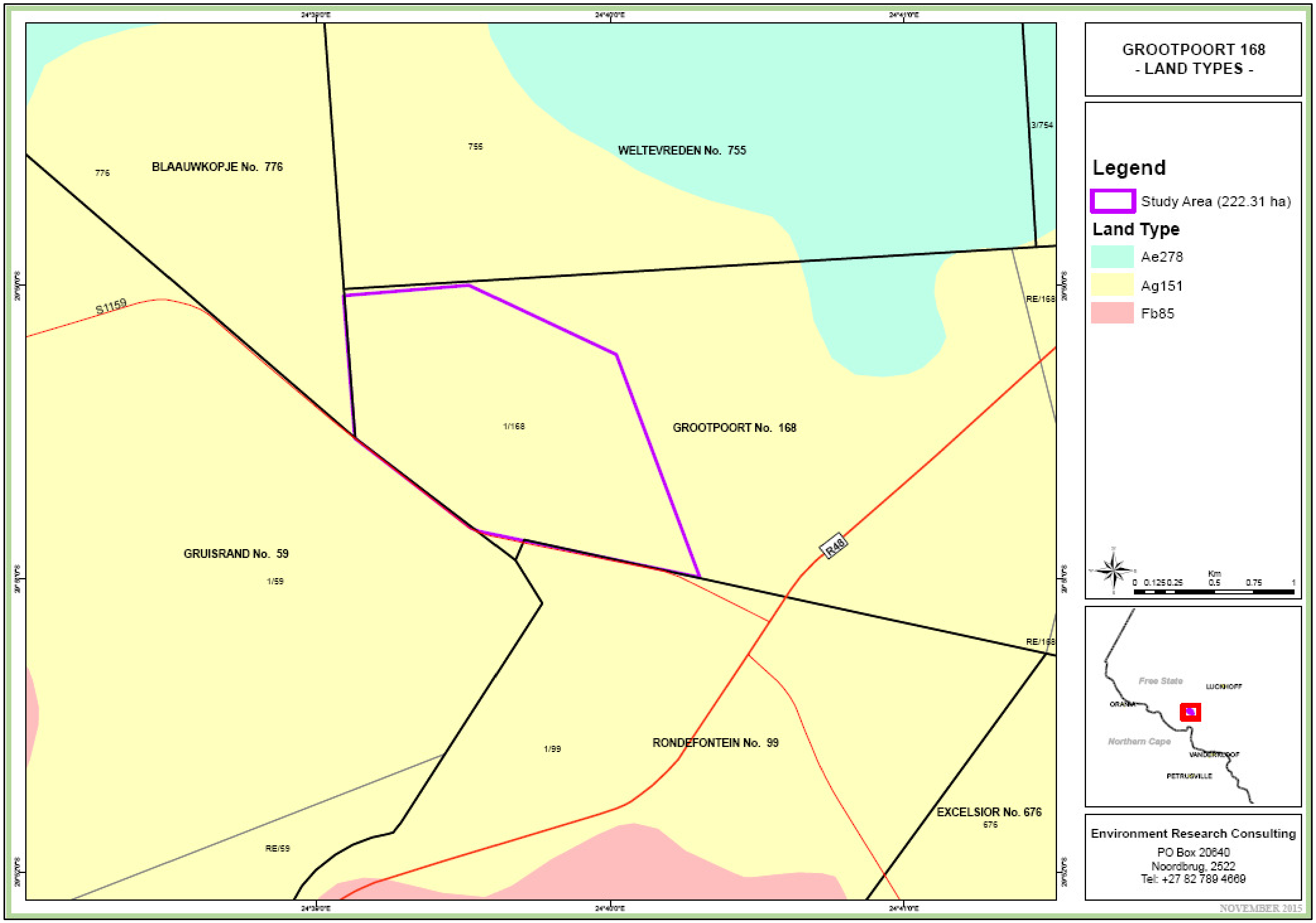

Figure 5: Land type map of the study area and surroundings (ENPAT Data, Dept. of Environmental Affairs).

7. SOIL CLASSIFICATION

7.1 Soil surveying and classification method

A systematic soil survey was undertaken with sampling points between 200m to 100m apart on the study area. Observations were made regarding soil texture, structure, depth, colour and the slope of the area.

Soils are described using the South African Taxonomic Soil Classification System (Soil Classification Working Group, 1991) published as memoirs on the Agricultural Natural Resources of South Africa No.15. Soils are grouped into classes with relatively similar soil characteristics. Where necessary, soils were grouped into classes with relatively similar soil properties and pedogenesis. A cold 10% hydrochloric acid solution was used on site to test for the presence of carbonates in the soil. A broad soil group reference based on international standards is also described (Fey, 2010).

Five composite soil samples were collected in the study area for physical and chemical soil analysis. Samples were analysed, amongst others, for clay content, pH, phosphorus content, macro nutrients (calcium, magnesium, and potassium) and electrical conductivity.

Note: Soil chemistry is discussed in more detail under section 8 of this report.

7.2 Soil classification

The occurrence of the recorded soil forms and the points at which the sampling for the soil classification took place are illustrated on Figure 6. Table 1 summarizes the recorded soil form groups and soil forms and the area and percentage of the study area that each soil form group underlies. Table 2 gives the coordinates of each classification point and also includes information regarding the soil form, depth of different soil horizons, effective total soil depth, soil colour and slope at each classification point. A total of 92 classification points were described during this study.

Two soil form groups with six soil forms were identified in the study area (Table 1). The site is characterized by mostly shallow to some moderately deep calcic, oxic and lithic soils with an average **effective soil depth** of only 53 cm. The shallowest soil profiles are less than 10 cm in depth and the deepest profile was measured at 130 cm.

For the largest part, the **soil colour** is fairly homogenous throughout the study area and most areas have a soil colour of 2.5 YR 5/4 according to the Munsell colour chart. Other colour variations that were recorded are 2.5 YR 5/6, 2.5 YR 4/4, 2.5 YR 4/3, 5 YR 5/4, 7.5 YR 5/4, 7.5 YR 5/6, 10 YR 4/4 and 10 YR 5/4.

Table 1: Summary of soil forms and the area (ha) that each covers in the study area

SOIL FORM GROUP	SOIL FORMS	AREA (ha)	% OF STUDY AREA	MAP COLOUR (Figure 6)
1. Moderately deep oxic to shallow lithic soils	Hutton (72%)	119.95	52	
	Mispah (28%)			
2. Moderately deep to shallow calcic soils	Kimberley (57%)	110.96	48	
	Plooysburg (23%)			
	Brandvlei (19%)			
	Coega (1%)			
	Total:	**230.91**	**100**	

Note: The Classification point numbers in Table 2 correspond to the numbered points on Figure 6.

Table 2: Information regarding soil forms and effective soil depth at each soil classification point in the study area

Soil form abbreviations: Br = Brandvlei; Cg = Coega; Hu = Hutton; Ky = Kimberley; Mi = Mispah; Py = Plooysburg

Classification point no.	Recorded soil form	A-hor. depth (cm)	B-hor. depth (cm)	Effective soil depth (cm)	A-hor. Soil Color (Munsel)	Estimated Slope (degrees)	GPS coordinates	
							S	E
1	Py	10	80	90	2.5 YR 5/4	1 - 5	29°50'02.85"	24°39'06.01"
2	Py	10	20	30	2.5 YR 5/4	1 - 5	29°50'02.78"	24°39'12.14"
3	Hu	10	30	40	2.5 YR 5/4	5 - 10	29°50'02.74"	24°39'19.61"
4	Py	20	100	120	2.5 YR 4/4	5 - 10	29°50'02.67"	24°39'27.00"
5	Py	20	40	60	2.5 YR 4/4	5 - 10	29°50'02.67"	24°39'34.16"
6	Py	10	30	40	2.5 YR 5/4	5 - 10	29°50'05.40"	24°39'41.72"
7	Py	20	50	70	2.5 YR 5/4	5 - 10	29°50'08.92"	24°39'49.13"
8	Ky	15	45	60	2.5 YR 5/4	5 - 10	29°50'09.00"	24°39'41.74"
9	Ky	20	60	80	2.5 YR 5/4	5 - 10	29°50'09.08"	24°39'34.29"
10	Hu	25	70	95	2.5 YR 5/4	5 - 10	29°50'09.16"	24°39'27.02"
11	Py	10	40	50	2.5 YR 5/4	1 - 5	29°50'09.23"	24°39'19.63"
12	Mi	20	-	20	2.5 YR 5/4	1 - 5	29°50'09.29"	24°39'12.12"
13	Py	15	30	45	2.5 YR 5/4	5 - 10	29°50'09.37"	24°39'06.74"
14	Hu	10	30	40	2.5 YR 4/4	5 - 10	29°50'15.57"	24°39'07.15"
15	Hu	10	30	40	2.5 YR 4/4	5 - 10	29°50'15.56"	24°39'12.10"
16	Hu	20	50	70	2.5 YR 5/4	5 - 10	29°50'15.52"	24°39'19.64"
17	Py	15	70	85	2.5 YR 5/4	5 - 10	29°50'15.45"	24°39'27.07"
18	Ky	20	60	80	2.5 YR 5/4	5 - 10	29°50'15.41"	24°39'34.28"
19	Ky	15	50	65	2.5 YR 4/4	5 - 10	29°50'15.41"	24°39'41.83"
20	Ky	25	60	85	2.5 YR 4/4	5 - 10	29°50'15.33"	24°39'49.22"

Classification point no.	Recorded soil form	A-hor. depth (cm)	B-hor. depth (cm)	Effective soil depth (cm)	A-hor. Soil Color (Munsel)	Estimated Slope (degrees)	GPS coordinates	
							S	E
21	Br	30	-	30	5 YR 5/4	5 - 10	29°50'15.34"	24°39'56.75"
22	Br	20	-	20	5 YR 5/4	5 - 10	29°50'15.26"	24°40'01.51"
23	Ky	25	80	105	7.5 YR 5/4	5 - 10	29°50'21.82"	24°40'03.90"
24	Br	15	-	15	7.5 YR 5/4	5 - 10	29°50'21.86"	24°39'59.36"
25	Ky	15	35	50	2.5 YR 4/4	5 - 10	29°50'21.88"	24°39'56.79"
26	Br	25	-	25	2.5 YR 5/4	5 - 10	29°50'21.93"	24°39'49.27"
27	Ky	20	40	60	2.5 YR 5/4	5 - 10	29°50'21.98"	24°39'41.91"
28	Ky	30	100	130	2.5 YR 5/4	5 - 10	29°50'22.09"	24°39'34.40"
29	Ky	20	70	90	10 YR 4/4	5 - 10	29°50'22.13"	24°39'27.07"
30	Hu	15	30	45	5 YR 5/4	5 - 10	29°50'22.16"	24°39'19.59"
31	Hu	15	40	55	2.5 YR 5/4	5 - 10	29°50'22.20"	24°39'12.09"
32	Cg	10	-	10	2.5 YR 5/4	1 - 5	29°50'22.25"	24°39'07.59"
33	Hu	20	20	40	2.5 YR 5/4	1 - 5	29°50'28.75"	24°39'08.08"
34	Hu	20	30	50	2.5 YR 5/4	1 - 5	29°50'28.68"	24°39'12.13"
35	Hu	20	50	70	10 YR 5/4	5 - 10	29°50'28.62"	24°39'19.65"
36	Hu	15	25	40	2.5 YR 5/4	5 - 10	29°50'28.55"	24°39'27.14"
37	Ky	25	100	125	2.5 YR 5/4	5 - 10	29°50'28.49"	24°39'34.42"
38	Ky	30	80	110	2.5 YR 4/4	5 - 10	29°50'28.36"	24°39'41.94"
39	Br	15	-	15	5 YR 5/4	5 - 10	29°50'28.36"	24°39'49.31"
40	Br	25	-	25	5 YR 5/4	5 - 10	29°50'28.28"	24°39'56.87"
41	Mi	15	-	15	7.5 YR 5/4	10 - 15	29°50'28.20"	24°40'04.26"
42	Hu	20	40	60	7.5 YR 5/6	5 - 10	29°50'34.84"	24°40'08.65"
43	Ky	20	65	85	5 YR 5/4	5 - 10	29°50'34.88"	24°40'04.31"
44	Ky	25	85	110	5 YR 5/4	5 - 10	29°50'34.95"	24°39'56.95"
45	Hu	25	75	100	5 YR 5/4	5 - 10	29°50'34.99"	24°39'49.39"

Classification point no.	Recorded soil form	A-hor. depth (cm)	B-hor. depth (cm)	Effective soil depth (cm)	A-hor. Soil Color (Munsel)	Estimated Slope (degrees)	GPS coordinates	
							S	E
46	Ky	30	90	120	2.5 YR 5/4	5 - 10	29°50'35.05"	24°39'42.03"
47	Ky	25	90	115	2.5 YR 5/4	5 - 10	29°50'35.05"	24°39'34.42"
48	Hu	15	40	55	2.5 YR 4/3	1 - 5	29°50'35.10"	24°39'27.11"
49	Hu	20	110	130	2.5 YR 4/3	5 - 10	29°50'35.20"	24°39'19.66"
50	Ky	15	45	60	10 YR 5/4	1 - 5	29°50'35.12"	24°39'13.67"
51	Hu	10	10	20	2.5 YR 5/4	1 - 5	29°50'40.69"	24°39'20.89"
52	Hu	5	30	35	2.5 YR 5/4	5 - 10	29°50'41.57"	24°39'27.14"
53	Mi	20	-	20	2.5 YR 5/4	5 - 10	29°50'41.49"	24°39'34.50"
54	Hu	30	90	120	2.5 YR 5/6	10 - 15	29°50'41.40"	24°39'42.05"
55	Mi	30	-	30	2.5 YR 5/6	10 - 15	29°50'41.37"	24°39'49.50"
56	Ky	20	50	70	2.5 YR 5/4	5 - 10	29°50'41.25"	24°39'56.97"
57	Hu	30	55	85	2.5 YR 5/6	10 - 15	29°50'41.24"	24°40'04.33"
58	Mi	10	-	10	2.5 YR 5/4	5 - 10	29°50'41.20"	24°40'11.21"
59	Mi	10	-	10	2.5 YR 5/4	5 - 10	29°50'47.65"	24°40'11.95"
60	Hu	20	50	70	2.5 YR 5/6	5 - 10	29°50'47.70"	24°40'04.49"
61	Hu	15	25	40	2.5 YR 5/4	10 - 15	29°50'47.74"	24°39'57.03"
62	Hu	25	100	125	2.5 YR 5/4	10 - 15	29°50'47.87"	24°39'49.53"
63	Mi	20	-	20	2.5 YR 5/4	1 - 5	29°50'47.86"	24°39'42.07"
64	Mi	25	-	25	2.5 YR 5/4	5 - 10	29°50'47.97"	24°39'34.55"
65	Br	15	-	15	7.5 YR 5/4	5 - 10	29°50'46.95"	24°39'28.87"
66	Br	30	-	30	5 YR 5/4	5 - 10	29°50'51.78"	24°39'42.21"
67	Mi	10	-	10	7.5 YR 5/4	5 - 10	29°50'53.17"	24°39'49.58"
68	Mi	10	-	10	7.5 YR 5/4	5 - 10	29°50'54.47"	24°39'57.08"
69	Hu	30	90	120	7.5 YR 5/6	5 - 10	29°50'54.43"	24°40'04.57"
70	Mi	30	-	30	7.5 YR 5/4	5 - 10	29°50'54.42"	24°40'12.00"

Classification point no.	Recorded soil form	A-hor. depth (cm)	B-hor. depth (cm)	Effective soil depth (cm)	A-hor. Soil Color (Munsel)	Estimated Slope (degrees)	GPS coordinates	
							S	E
71	Mi	10	-	10	7.5 YR 5/4	5 - 10	29°50'54.38"	24°40'16.04"
72	Mi	25	-	25	7.5 YR 5/4	5 - 10	29°50'57.98"	24°40'12.05"
73	Mi	15	-	15	7.5 YR 5/4	1 - 5	29°50'59.06"	24°40'17.70"
74	Mi	15	-	15	7.5 YR 5/4	1 - 5	29°50'38.67"	24°39'49.41"
75	Mi	25	-	25	2.5 YR 5/4	10 - 15	29°50'35.09"	24°39'31.00"
76	Mi	15	-	15	2.5 YR 5/4	10 - 15	29°50'38.77"	24°39'34.32"
77	Mi	10	-	10	2.5 YR 5/4	20 - 30	29°50'41.49"	24°39'38.40"
78	Mi	10	-	10	2.5 YR 5/4	20 - 30	29°50'44.65"	24°39'42.04"
79	Mi	15	-	15	2.5 YR 5/4	15 - 20	29°50'47.99"	24°39'46.31"
80	Br	25	-	25	5 YR 5/4	5 - 10	29°50'50.11"	24°39'34.46"
81	Br	30	-	30	7.5 YR 5/4	5 - 10	29°50'44.50"	24°39'28.36"
82	Mi	20	-	20	2.5 YR 5/4	5 - 10	29°50'41.47"	24°39'30.51"
83	Cg	15	-	15	2.5 YR 5/4	1 - 5	29°50'18.74"	24°39'12.07"
84	Cg	20	-	20	2.5 YR 5/4	1 - 5	29°50'19.11"	24°39'07.24"
85	Py	15	35	50	2.5 YR 5/4	1 - 5	29°50'12.34"	24°39'19.88"
86	Hu	25	75	100	2.5 YR 5/4	5 - 10	29°50'06.62"	24°39'26.98"
87	Ky	25	50	75	2.5 YR 5/4	5 - 10	29°50'09.19"	24°39'30.56"
88	Ky	20	60	80	2.5 YR 5/4	5 - 10	29°50'15.47"	24°39'31.17"
89	Br	30	-	30	2.5 YR 5/4	5 - 10	29°50'19.26"	24°39'49.00"
90	Ky	20	40	60	5 YR 5/4	5 - 10	29°50'25.14"	24°39'56.82"
91	Hu	25	50	75	2.5 YR 5/6	5 - 10	29°50'38.23"	24°40'04.49"
92	Hu	20	50	70	2.5 YR 5/4	5 - 10	29°50'44.84"	24°39'56.93"
	Averages:	**19**	**55**	**53**				

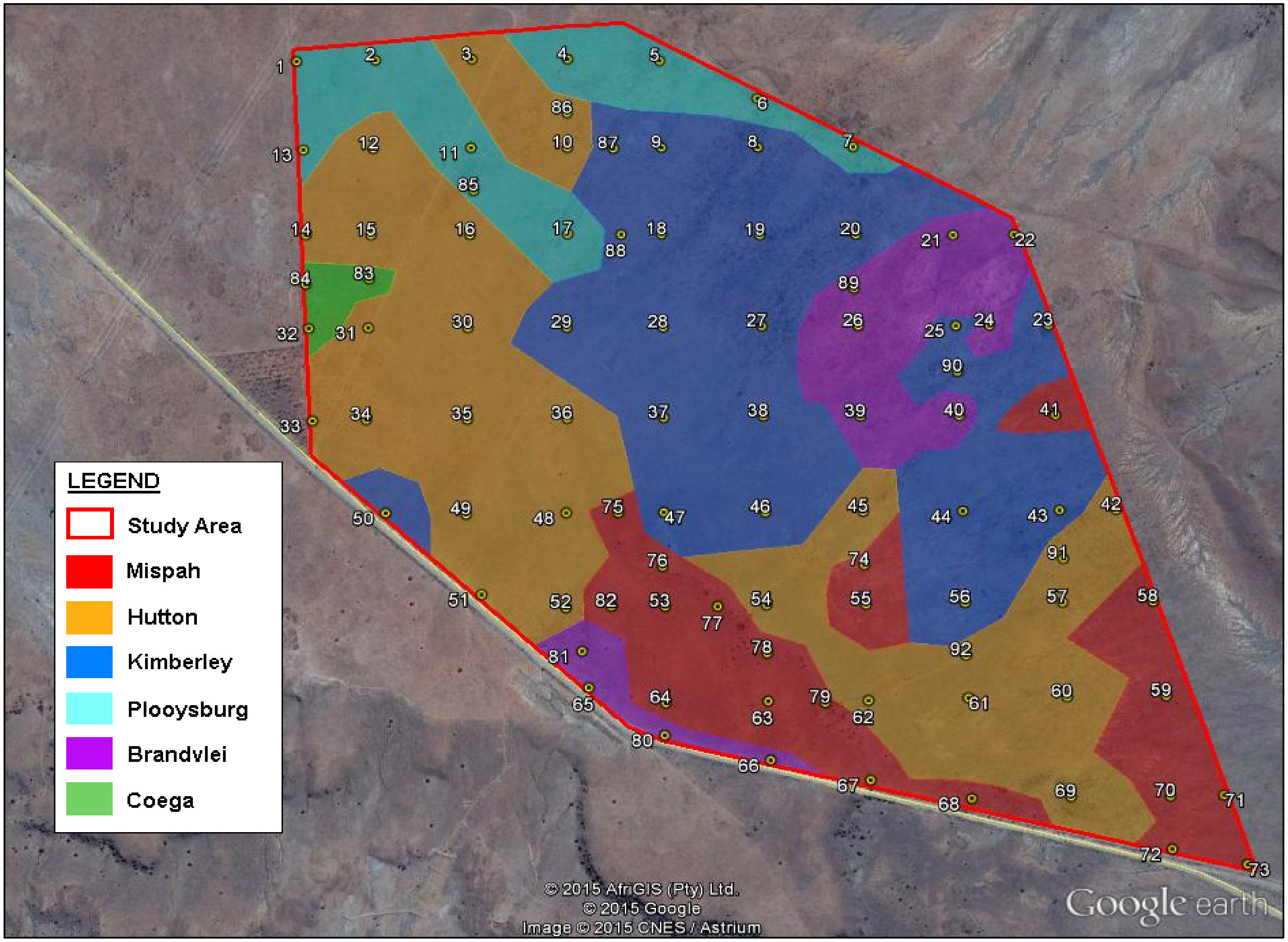

Figure 6: Google earth image indicating the study area with the soil forms recorded and the points where soil classification was done.

7.3 Description of Soil Form Groups

7.3.1 Oxic and lithic soils

This soil form group consists of two soil forms namely the Hutton and Mispah forms. These soil forms were grouped together due to its position in the landscape and the small distances between the different forms. In the study area these soil forms are characterised by shallow to moderately deep profiles where a red apedal sandy horizon overlies either rock (Mispah), unspecified material without signs of wetness (Hutton).

Overall approximately 52 % (120 ha) of the study area falls in this soil form group and has variations in effective soil depth from 10 to 125 cm with an average effective soil depth of 45 cm.

Oxic soils (Hutton soil form):

Soils with oxic horizons refer to soils with a sandy loam or a finer texture with a low cation-exchange capacity, a low content of primary weatherable minerals and are at least 30 cm thick. The clay-sized fraction generally is dominated by 1:1 layer clays (i.e. kaolinite) and the silt and sand fraction is generally dominated by quartz with some other resistant minerals.

The Hutton (Hu) soil form, which consists of an orthic A-horizon on a red apedal, oxic horizon, underlays approximately 37 % (86 ha) of the study area and varies in effective soil depth from 40 to 125 cm (average: 68 cm). This soil form is may be suitable for crop production, but due to the overall moderate to shallow effective soil depth as well as the soil depth significantly varying over short distances, it is not suitable for large scale crop production in this particular study area.

Lithic soils (Mispah soil form):

Lithic soils (Lithosols) are shallow stony soils, i.e. soils with hard rock at shallow depths and also include soils consisting of freshly and imperfectly weathered rock or rock fragments with no clearly expressed soil morphology. This soil form is not suitable to crop production due to the shallow soil depth.

Lithosols in the study area are represented by the Mispah (Mi) soil form, which consists of an orthic A-horizon on shallow hard rock, which in the case of this study area is mostly shale. Approximately 15 % (34 ha) of the study area is underlain by Mi soils. These soils vary in depth from 5 to 30 cm (average: 17 cm).

7.3.2 Calcic soils

The carbonate-rich horizons that characterise calcic soils are a result of the continuing accumulation of especially calcium, but also magnesium carbonate over a long period of time. The conditions needed for the development of these calcic soils are strongly governed by an arid or semi-arid climate. Furthermore, calcic soils are low in organic matter as a result of generally sparse vegetation cover and the rapid decomposition of organic material in the often hot and dry conditions. These same conditions, however, result in the soils being base-rich with little leaching of plant nutrients. The exchange complex is nearly always close to being 100% saturated with calcium and magnesium as the dominant cations. The pH of calcic soils is usually close to neutral in the topsoil and somewhat higher in the sub-surface horrizons, where carbonate is more common and the acidifying influence of the organic matter mitigated.

The calcic soils recorded in the study area include soils of the Coega, Kimberley, Plooysburg and Brandvlei forms.

Coega and Brandvlei soil forms:

The Coega soil form (Cg) consists of an orthic A-horizon on a hardpan carbonate horizon, whereas the Brandvlei (Br) form consists of an orthic A-horizon on a soft carbonate horizon. In both instances the orthic A-horizon has a bleached colour, sandy loam texture and is never deeper than 30 cm in the Cg form and 10 to 40 cm deep in the Br form. The hardpan carbonate horizon of the Cg form is massive and extremely hard and acts as a barrier to root growth. It is also only slowly permeable to water and in low laying parts of the landscape, these areas can form temporary pans after rain events. The Cg soil form is not suitable to crop production due to the shallow soil depth. In the Br form the soft carbonate layer dominates the morphology of the B-horizon but is not as hard and impermeable as the hardpan carbonate horizon of the Cg form. The Br soil form is not suitable to crop production due to the shallow effective soil depth and generally high inherent salt content.

Approximately 1.4 % (0.6 ha) of the study area is underlain by the Cg soil form, which varies in depth from 10 to 20 cm (average: 15 cm). The Br form underlays about 21 % (9.1 ha) of the study area with the overall effective soil depth varying between 15 to 30 cm (average: 24 cm).

Kimberley and Plooysburg soil forms:

The Kimberley (Ky) soil form consists of a red apedal sandy horizon overlaying a soft carbonate horizon and the Plooysburg (Py) form of a red apedal sandy horizon overlaying a hardpan carbonate horizon. In both cases the red apedal B-horizon as oxic in nature and is not entirely dissimilar from the description given for the Hu soil form. In places where the soft carbonate horizon of the Ky form is deep enough below the soil surface, crop production is entirely possible on such soils but more marginally possible on Py forms due to the poor permeability of the hardpan carbonate in lower end of the soil profile. In the case of this study area large scale crop production will be difficult to achieve due to the soil depth varying significantly over short distances.

The Ky form underlays approximately 28 % (63.6 ha) of the study area with an effective soil depth of between 50 to 130 cm (average: 86 cm). Approximately 11 % (25 ha) is underlain by the Py form with an effective soil depth of between 40 and 120 cm (average: 65 cm).

8. SOIL CHEMISTRY

8.1 Soil chemical characteristics and soil fertility

A chemical analysis of five representative composite soil samples that were collected in the study area is included as baseline data. The results of the analyses are included in Table 4 (p.24). All soil samples were taken as representative composite samples of the top 30 cm of all the recorded soil forms in the study area. Sample 1 was taken on Hutton (Hu) soils, sample 2 on Kimberley (Ky) soils, sample 3 on Mispah soils, sample 4 on Plooysburg and sample 5 on Brandvlei and Coega soils. As Hu and Ky are the two dominant soil forms in the study area, collectively samples 1 and 2 represent 65% of the soil chemical status of study area.

8.1.1 Soil pH

Soil pH is an indicator of soil acidity and alkalinity. Most soils have a pH in the range of 4 to 10. The pH of a particular soil, such as 5 or 8, reflects a certain chemical and mineralogical environment in that specific soil, and therefore the pH is of great importance to plant roots and microbial activity. Soil pH is one of the most important factors affecting soil fertility. Many parent materials and young soils are alkaline, but old and intensely weathered soils are typically acidic. Descriptive terms commonly associated with different ranges in soil pH are presented in Table 3.

Table 3: Terminology associated with soil pH

pH range	Description
< 4,5	Extremely acidic
4,5 – 5,0	Very strongly acidic
5,1 – 5,5	Strongly acidic
5,6 – 6,0	Moderately acidic
6,1 – 6,5	Mildly acidic
6,6 – 7,3	Neutral
7,4 – 7,8	Mildly alkaline
7,9 – 8,4	Moderately alkaline
8,5 – 9,0	Strongly alkaline
> 9,0	Very strongly alkaline

The pH of the analysed soil samples, collected in the study area, range between 5.4 and 7.3 (Table 4). According to the descriptions of Table 3, Sample 3 can be described as strongly acidic, Sample 1 has a pH of 6.4 and is therefore mildly acidic and Samples 2 (pH 6.7), 4 (pH 7.1) and 5 (pH 7.3) are neutral.

8.1.2 Other soil elements

Soil fertility describes the potential of land for successful crop production. Soil fertility can usually be improved by the addition of chemical fertilizers. However, with sharp increases in the price of these fertilizers and the negative environmental impact that these chemicals have on groundwater and surface water runoff quality it is becoming increasingly important to manage the inherent soil fertility correctly. This fertility is the combined result of the cation exchange capacity (CEC) of the soil, as well as the exchangeable bases namely calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na). The nutrient status of a soil is expressed in terms of mg/kg.

Potassium plays many essential roles in plants. It is extremely mobile within the plant and helps regulate the opening and closing of stomata in the leaves as well as the uptake of water by root cells. It is also essential for photosynthesis, protein synthesis and starch formation. Potassium levels are moderate to moderately high with values ranging between 91 and 197 mg/kg. According to the lab results the phosphorus (P) levels for all analysed samples is 0.0 mg/kg, which reflects a serious P deficiency. Although these are very low P concentrations for a crop production situation, these are not unusual levels for South African arid veld conditions. The cation chemistry (Ca, Mg, K, Na – content and relationships) is typical to that of the soil forms in the area of the proposed project. As may be expected in calcic soils the Ca content of samples 2, 4 and 5 is somewhat higher than that of the other two soils. No serious extremes in terms of the soil chemistry were recorded.

8.1.3 Soil texture

The soil texture (Table 4) of all collected samples were analysed and all have a clay content of ≤10 %. Also noticeable is the fact that sample 5 (Br) has a silt content of 12%, which is between two to almost four times that of the other samples. All soils in the study area are classified as loamy-sand soils.

Table 4: Laboratory results of the analyses of 5 composite soil samples collected in the study area.

Sample no.	pH(KCl)	P (Bray1)	K		Ca		Mg		Na		S-Value
		mg kg^{-1}	cmol kg^{-1}	mg kg^{-1}	cmol kg^{-1}	mg kg^{-1}	cmol kg^{-1}	mg kg^{-1}	cmol kg^{-1}	mg kg^{-1}	cmol kg^{-1}
(1) Hu	6.40	0.0	0.51	197.0	8.39	1682.0	3.53	428.5	0.04	9.5	12.47
(2) Ky	6.73	0.0	0.23	90.5	9.74	1952.0	3.98	483.5	0.10	23.0	14.05
(3) Mi	5.39	0.0	0.42	164.5	7.08	1418.0	4.17	506.5	0.09	21.5	11.76
(4) Py	7.13	0.0	0.36	138.5	18.68	3744.0	3.40	413.0	0.05	11.5	22.49
(5) Br/Cg	7.27	0.0	0.27	104.0	25.45	5100.5	4.06	493.5	0.13	29.5	29.91

Sample no.	Ca:Mg	Mg:K	Ca+Mg:K	K%	Ca%	Mg%	Na%	Particle size distribution (%)			
								>2mm	Sand	Silt	Clay
(1) Hu	2.38	6.98	23.60	4.05	51.34	28.29	0.33	2.2	86.4	3.4	8.0
(2) Ky	2.45	17.15	59.12	1.65	47.89	28.32	0.71	2.9	85.3	3.7	8.1
(3) Mi	1.70	9.88	26.66	3.59	45.83	35.45	0.79	1.2	82.4	6.4	10.0
(4) Py/Cg	5.50	9.57	62.18	1.58	31.71	15.12	0.22	1.4	87.6	3.6	7.8
(5) Br	6.27	15.23	110.67	0.89	24.31	13.58	0.43	1.3	78.6	12.1	8.0

Note: All soil sample analyses were conducted within 10 days of collection by Eco-Analytica at the Northwest University (Tel: 018 293 3900). To ensure the integrity of analyses, Eco-Analytica participates in the control schemes of the following institutions:

- Agri-Laboratory Association of southern Africa.
- International Soil-Analytical Exchange (ISE), Wageningen, Netherlands.

No responsibility will however be taken by the Northwest University or ERC for any losses caused by the use of this data.

9. AGRICULTURAL POTENTIAL

Due to the low annual rainfall in the study area it cannot be considered for dry land crop production. There is a marginal potential for crop production under irrigation, but that potential is further marginalized by the soil characteristics of the studied site as well as the distance and elevation with regards to the supply of irrigation water. It is unclear what the potential of sub-terrainian water is on the site, but no boreholes were observed on or near the studied area. The site may, however, be supplied with irrigation water from the nearby scheme from the Van der Kloof Dam.

Although marginally deep profiles were augured, the soil profile over the course of the study area varies significantly where the soil can be 120 cm deep at one point and vary to 40 cm in depth less than 100 m further. However, the largest part of the studied area has soils that are less than 70 cm deep and the overall average effective soil depth is only 53 cm.

The Hutton soil profiles in the study area are best suited for any form of irrigation farming. Although they are relatively shallow in places these areas may be suitable as arable land given the right amount of irrigation water. The Mispah areas are far too irregular in terms of topography and soil depth to be considered. The areas underlain by the calcic soils are less suitable as these types of soils are known to be less permeable and for the build-up of salts in the sub-soil.

Overall the study area is only marginally suitable for irrigation farming and may even be considered unsuitable due to the irregular soil patterns and depth, general slope of between 5 to 10 degrees and it is suspected that the mere cost of supplying irrigation water to the site will far exceed the potential for crop production.

The potential for livestock farming seems to be rather low as well. This is due to the observation that a large portion of the studied area has a very low estimated veld condition. Some areas, especially the south-western portions have good grass cover (Figure 7), but is currently heavily grazed by game and sheep and signs of overgrazing in the past, in the form of the increase of less palatable dwarf shrubs, were also observed. Some areas are severely degraded with little grass cover and many poorly palatable dwarf shrubs dominating the herbaceous layer (Figure 8).

Figure 7: Area with fairly good grass cover and moderate veld condition

Figure 8: Degraded area with no grass cover and poor veld condition

9.1 Water availability

There is a major irrigation canal passing about 1 km south-east of the south-eastern corner of the study area. This large canal originates from the Van der Kloof Dam and eventually ends up at the large irrigation scheme west of Jacobsdal. The Orange River passes approximately 6 km south of the study area, but the potential of directly drawing irrigation water from that source is non-existent. No boreholes were observed on or near the studied area.

The site does not currently accommodate any centre pivots, irrigation schemes or active agricultural fields. There are no current arable lands which could be impacted upon by the proposed development.

9.2 Conclusions on agricultural potential

It can be concluded the study site has no potential for dry land crop farming, but may have a marginal potential for small scale crop production under irrigation. A major irrigation canal from the Van der Kloof Dam passes about 1 km south-east of the south-eastern corner of the study area, which may be able to supply water for irrigation. This water will however have to be pumped to the site as it is situated slightly higher up the landscape from the canal.

However, overall the study area is regarded as only marginally suitable for irrigation farming and may even be considered unsuitable due to the irregular soil patterns and depth, general slope of between 5 to 10 degrees and it is suspected that the mere cost of supplying irrigation water to the site will far exceed the potential for crop production. According to the available Land Type information these conclusions, in terms of the potential for arable land in the study area, are confirmed in Figure 9, which gives an indication of the irrigation potential of the study area according to the ENPAT data base of the Department of Agriculture. The site has some potential for sheep, goat and/or game farming although the current veld condition is estimated to be below 30 %. This situation can, however, be turned around with resting the veld for a season or two and naturally with some good rainfall.

It can therefore be concluded that should the development be authorised, it will have a moderately low impact on agricultural potential in terms of crop production as well as the production of livestock and game.

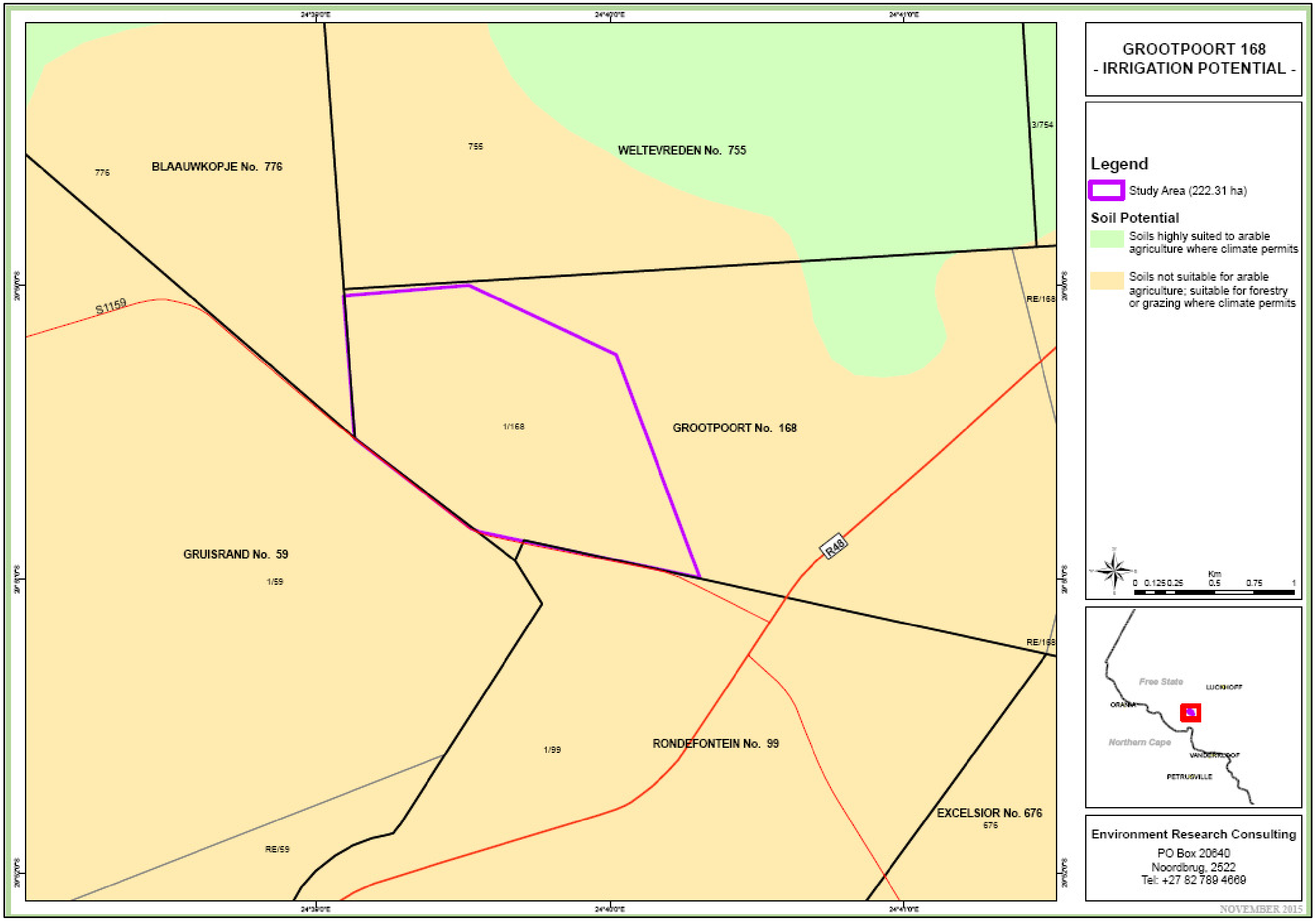

Figure 9: Irrigation potential for soils in the study area and surroundings (ENPAT Data, Dept. of Environmental Affairs).

10. LAND USE AND LAND CAPABILITY

10.1 Current land use and land capability

Fencing in and around the studied area consist of a game fence on the western, south-western and southern boundaries. A six strand cattle fence divides the study area from south-west along a road that leads to the farm's homestead approximately 3 km north of the study area.

Areas of serious gully erosion (some gullies are up to 1 m deep) were observed (Figure 10) especially in the south-eastern parts of the study area where water drains away from the low ridge on the study area. Areas with serious sheet erosion towards the eastern and north-eastern parts of the study area were also observed.

Figure 10: Erosion gullies on the south eastern side of the low ridge on site.

There are no buildings or other permanent farming infrastructure such as cattle kraals, dips, etc. constructed on site. The only road infrastructure on site consists of well-maintained farm road towards the western boundary. A district/provincial dirt road runs past the south-western and southern boundary of the studied area.

Van Oudtshoorn (1999) emphasizes the fact that grasses and the soil that it grows in are one of our most valuable natural resources and that we (the land users) should do all that is in our power to conserve it in a good condition for future generations. Care should be taken not to injudiciously destroy or degrade natural rangelands. It is recommended that the natural veld in the area of the solar panels be utilized by game or other livestock if at all possible. The reason for this recommendation is that under-utilization of natural veld in the long run is just as detrimental to the sustainability of natural veld as is the case with over utilization. According to Van Oudtshoorn (1999) a tuft of grass will smother from the inside if dead plant material is allowed to accumulate when no defoliation takes place through grazing or periodic burning. The effects of under-utilization, just as with over utilization, may also cause the deterioration of the veld condition, which will lead to bare patches in the vegetation and subsequently lead to higher levels of erosion and soil surface deterioration. If grazing is not an option, grass cutting (to be used or sold as dry fodder in the form of bales) or periodic burning is strongly recommended.

10.2 Surrounding land use and land capability

The surrounding land in the area is also used for extensive cattle and possibly game farming activities. No crop farming or visible tourism activities are present within a 1 km radius surrounding the site.

It is anticipated that the proposed change in land use of the study site will not result in any negative impact on the surrounding land users as it should not result in any physical or chemical pollution that will affect neighbouring properties and farming practises.

11. IMPACT ASSESSMENT

11.1 Methodology

Impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An activity is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructures that are possessed by an organisation.
- An environmental aspect is an 'element of an organizations activities, products and services which can interact with the environment[1]. The interaction of an aspect with the environment may result in an impact.

Environmental risks/impacts are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.

- Receptors can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems.
- Resources include components of the biophysical environment.
- Frequency of activity refers to how often the proposed activity will take place.
- Frequency of impact refers to the frequency with which a stressor (aspect) will impact on the receptor.
- Severity refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact

[1] The definition has been aligned with that used in the ISO 14001 Standard.

(increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.

- Spatial extent refers to the geographical scale of the impact.
- Duration refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria. Refer to the tables below. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary[2].

The assessment of significance is undertaken twice. Initial significance is based on only natural and existing mitigation measures (including built-in engineering designs). The subsequent assessment takes into account the recommended management measures required to mitigate the impacts. Measures such as demolishing infrastructure and reinstatement and rehabilitation of land are considered post-mitigation. The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information to be in line with international best practice guidelines in instances of uncertainty or lack of information by increasing assigned ratings or adjusting final model outcomes. In certain instances where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

[2] Some risks/impacts that have low significance will however still require mitigation

Table 5: Criteria for assessing significance of impacts:

CONSEQUENCE DESCRIPTORS

Severity of impact	**RATING**
Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful	5
Spatial scope of impact	**RATING**
Activity specific	1
Development specific (within the site boundary)	2
Local area (within 5 km of the site boundary)	3
Regional	4
National	5
Duration of impact	**RATING**
One day to one month	1
One month to one year	2
One year to ten years	3
Life of operation	4
Permanent	5

Table 6: Criteria for assessing significance of impacts:

LIKELIHOOD DESCRIPTORS

Frequency of activity/ duration of aspect	**RATING**
Annually or less / low	1
6 monthly / temporary	2
Monthly / infrequent	3
Weekly / life of operation / regularly / likely	4
Daily / permanent / high	5
Frequency of impact	**RATING**
Almost never / almost impossible	1
Very seldom / highly unlikely	2
Infrequent / unlikely / seldom	3
Often / regularly / likely / possible	4
Daily / highly likely / definitely	5

Table 7: Significance rating matrix

	CONSEQUENCE (Severity + Spatial Scope + Duration)														
LIKELIHOOD (Frequency of activity + Frequency of impact)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table 8: Positive/Negative Mitigation Ratings

Significance Rating	Value	Negative Impact Management Recommendation	Positive Impact Management Recommendation
Very high	126-150	Improve current management	Maintain current management
High	101-125	Improve current management	Maintain current management
Medium-high	76-100	Improve current management	Maintain current management
Medium-low	51-75	Maintain current management	Improve current management
Low	26-50	Maintain current management	Improve current management
Very low	1-25	Maintain current management	Improve current management

<u>Impact assessment considerations</u>

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the project's area of influence encompassing:
    - Primary project site and related facilities that the client and its contractors develop or control;

- Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
- Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.

➢ Risks/Impacts were assessed for all stages of the project cycle including:

- Construction;
- Operation; and
- Rehabilitation.

➢ If applicable, trans-boundary or global effects were assessed;

➢ Individuals or groups who may be differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status were assessed.

Mitigation measure development

The following points present the key concepts considered in the development of mitigation measures for the proposed development.

➢ Mitigation and performance improvement measures and actions that address the risks and impacts[3] are identified and described in as much detail as possible.

➢ Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation.

➢ Desired outcomes are defined, and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, with estimates of the resources (including human resource and training requirements) and responsibilities for implementation.

[3] Mitigation measures should address both positive and negative impacts

11.2 Impact rating

Due to the nature of the project and the aim of generating sustainable electricity from a renewable energy source, it is not foreseen that there will be a decommissioning phase for this project. Four possible impacts on soil resulting from the proposed project are expected. These impacts are:

- Soil erosion due to increased run-off from the surfaces of the panels of the photo-voltaic plant.
- Soil compaction caused by transport of equipment on and off site during construction and operation. This also includes transport during the operational phase to do maintenance work.
- Chemical soil pollution that may result from batteries being disposed of during the decommissioning phase as well as fuel and oil spills from vehicles transporting equipment.
- Change in current grazing land use.

11.2.1 Impact 1: Soil erosion

Environmental significance:

Soil erosion should not be a major problem during the construction phase for the PV plants will be cemented into the soil and very little natural vegetation will be removed. The largest risk factor for soil erosion will be during the operational phase when storm water run-off from the surfaces of the photo-voltaic panels could cause erosion.

Erosion will be localised within the site boundary but will have a permanent effect that would stretch into the operational phase of the project. This will ultimately lead to the irretrievable commitment of this resource. The measurable effect of reducing erosion by utilising mitigation measures may reduce possible erosion significantly. The significance of this potential impact is considered to be high.

Assessment of impact before mitigation

Likelihood		Consequence			
Frequency of activity	*Freq of impact*	*Benefit/Severity of impact*	*Spatial/Population Scope*	*Duration*	*Rating*
5 Highly likely	4 Often	4 Great	3 Local area	5 Permanent	High
Score	9	12			108

Mitigation measures:

- To avoid soil erosion, it will be a good practice to design storm water canals into which the water from the panels can be channelled. These canals should reduce the speed of the water and allow the water to drain slowly onto the land.
- Another important measure is to avoid stripping land surfaces of existing vegetation by only allowing vehicles to travel on existing roads and not create new roads.

Through mitigation measures the potential impact can be reduced from high to low.

Assessment of impact after mitigation

Likelihood		Consequence			
Frequency of activity	*Freq of impact*	*Small*	*Spatial/Population Scope*	*Duration*	*Rating*
4 Life of operation	2 Highly unlikely	1 Insignificant	3 Local area	4 Life of operation	Low
Score	6	8			48

11.2.2 Impact 2: Soil compaction

Environmental significance:

Soil compaction due to unnatural load in the area will change the soil structure. It is expected that soil compaction will increase because of the increase in vehicular activity on the proposed development site. The effect of this will largely be within the site boundary and will continue during the operational phase. If possible mitigating measures are not implemented the effect of the compaction will affect soil structure of soils on the site. The significance of this potential impact is considered to be medium-high.

Assessment of impact before mitigation

Likelihood		**Consequence**			
Frequency of activity	*Freq of impact*	*Benefit/Severity of impact*	*Spatial/Population Scope*	*Duration*	*Rating*
4 Regularly	2 Temporary	3 Significant	3 Local area	4 Life of operation	Medium-High
Score	6	10			90

Mitigation measures:

- The most effective mitigation will be the minimisation of the project footprint by using the existing roads in the area and not create unnecessary new roads to prevent other areas also getting compacted.

Therefore the effect of compaction mitigation will be localised within the area and will only have an effect during the construction and operational years. The significance of this potential impact, after mitigation, is considered to be low.

Assessment of impact after mitigation

Likelihood		**Consequence**			
Frequency of activity	*Freq of impact*	*Benefit/Severity of impact*	*Spatial/Population Scope*	*Duration*	*Rating*
2 Temporary	3 Infrequent	2 Potentially harmful	2 Study area specific	4 Life of operation	Low
Score	5	8			40

11.2.3 Impact 3: Chemical soil pollution

Environmental significance:

The use of vehicles that can result in oil and fuel spills on site as well as waste generation by construction and construction workers can result in possible chemical soil pollution. Chemical soil pollution can also be caused by injudicious discarding of broken and/or old batteries on site. The effect can stretch beyond the site boundaries and the significance of this potential impact is considered to be high.

Assessment of impact before mitigation

Likelihood		**Consequence**			
Frequency of activity	*Freq of impact*	*Benefit/Severity of impact*	*Spatial/Population Scope*	*Duration*	*Rating*
5 Permanent	5 Daily	4 Harmful	3 Local area	4 Life of operation	High
Score	10	11			110

Mitigation measures:

Soil pollution within and outside the site boundary can be prevented through mitigation the anticipated impact can be reduced from high to low. The following mitigation measures are suggested:

- All waste generated on site during construction should be stored in waste bins and removed from site on a regular basis.
- Vehicles accessing the site should regularly be checked for fuel and oil spills. In case of spillage, the contaminated soil should be removed and transported to a designated waste site.
- No broken or old batteries or components of the PV plant should be dumped on or around the site but should be removed immediately and taken to a special chemical waste facility.

Assessment of impact after mitigation

Likelihood		**Consequence**			
Frequency of activity	*Freq of impact*	*Benefit/Severity of impact*	*Spatial/Population Scope*	*Duration*	*Rating*
2 Temporary	5 Infrequent	1 Insignificant	3 Local	4 Life of operation	Low
Score	5	8			35

The significance of this potential impact, after mitigation, is considered to be low.

11.2.4 Impact 4: Change in grazing land use

Environmental significance:

The use of the area for the construction and operation of the PV plant will result in the area not being used for livestock grazing anymore. This will result in the loss of grazing for game and livestock. However, this impact is low.

Assessment of impact before mitigation

Likelihood		**Consequence**			
Frequency of activity	*Freq of impact*	*Benefit/Severity of impact*	*Spatial/Population Scope*	*Duration*	*Rating*
5 Definitely	1 Annually	1 Insignificant	3 Local area	4 Life of operation	Low
Score	6	8			48

Mitigation measures:

Due to the permanent nature of the project it is not foreseen that it can be mitigated to any lower impact.

11.3 Impact summary

Based on the above assessment it is evident that there are four possible impacts on the soil and current land use of the area observed. Table 9 below summarises the findings indicating the significance of the impact before mitigation takes place and the likely impact if management when mitigation takes place. In the consideration of mitigation it is assumed that a high level of mitigation takes place but does not lead to prohibitive costs. From Table 9 it is evident that prior to mitigation all of the impacts range between high and low level impacts but with proper mitigation measures all impacts can be reduced to low level.

Table 9: A summary of the results impacts assessed

Impact	**Impact level pre-mitigation**	**Impact level post mitigation**
Soil erosion	High	Low
Soil compaction	Medium-high	Low
Chemical soil pollution	High	Low
Change in grazing land use	Low	Low

12. REFERENCES

Brady, N.C., and Weil, R.R. 2008. Elements of The Nature and Properties of Soils, 4th edn. Upper Saddle, NJ: Prentice-Hall.

Fey, M. 2010. Soils of South Africa. Cambridge University Press.

Geological Survey, 1984. Geological map of the Republic of South Africa. Department of Mineral and Energy Affairs, Pretoria.

MacVicar, C.N. 1977. Soil Classification: A Binominal System for South Africa. Dept of Agricultural Technical Services, Pretoria.

The Soil Classification Working Group, 1991. *Soil Classification – Taxonomic System for South Africa.*Dept. of Agric., Pretoria.

Van Oudtshoorn, F.P. 1992. Guide to the Grasses of Southern Africa. Briza Publications. Pretoria.